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ORIGINAL CONTRIBUTIONS

Clinical Features and Outcome of Postoperative Peritonitis Following Bariatric Surgery

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Abstract
Background We assessed the clinical features and outcome of morbidly obese patients admitted to the intensive care unit (ICU) for management of postoperative peritonitis (POP) following bariatric surgery (BS).
Methods In a prospective, observational, surgical ICU cohort, we compared the clinical features, empiric antibiotic therapy, and prognosis of BS patients with those developing POP after conventional surgery (cPOP).
Results Overall, 49 BS patients were compared to 134 cPOP patients. BS patients were younger (45±10 versus 63±16 years; $p<0.0001$), had lower rates of fatal underlying disease (39 vs 64 %; $p=0.002$), and the same SOFA score at the time of reoperation (8±4 vs 8±3; $p=0.8$) as the cPOP patients. BS patients had higher proportions of Gram-positive cocci (48 vs 35 %; $p=0.007$) and lower proportions of Gram-negative bacilli (33 vs 44 %; $p=0.03$), anaerobes (4 vs 10 %; $p=0.04$), and multidrug-resistant strains (20 vs 40 %; $p=0.01$). Despite higher rates of adequate empiric antibiotic therapy (82 vs 64 %; $p=0.024$) and high de-escalation rates (67 % in BS cases and 51 % in cPOP cases; $p=0.06$), BS patients had similar reoperation rates (53 vs 44 %; $p=0.278$) and similar mortality rates (24 vs 32 %; $p=0.32$) to cPOP patients. In multivariate analysis, none of the risk factors for death were related to BS.
Conclusions The severity of POP in BS patients resulted in high mortality rates, similar to the results observed in cPOP. Usual empiric antibiotic therapy protocols should be applied to target multidrug-resistant microorganisms, but de-escalation can be performed in most cases.

Keywords Bariatric surgery · Morbid obesity · Postoperative peritonitis · Sepsis · Multidrug-resistant bacteria · Antibiotic adequacy · Antibiotic de-escalation

Introduction

Very few data are available concerning the clinical characteristics of postoperative infections following bariatric surgery (BS) in patients admitted to intensive care unit (ICU) [1]. From the ICU physician's standpoint, this subset of patients represents new and challenging issues and raises specific concerns. In a group of patients referred to our ICU with a diagnosis of postoperative peritonitis (POP), we have previously reported delayed identification of complications, frequently at the time of organ dysfunction [2]. In order to identify the most relevant features in these patients, we conducted a prospective observational study to compare the clinical characteristics and outcome of a group of patients admitted to our ICU for POP following BS (called BS

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cases) and a group of patients who developed POP following conventional surgery (called cPOP).

Patients and Methods

Patient Selection

The study was approved by the local institutional review board (CEERB CHU Bichat Paris VII University, Paris), which waived the need for signed informed consent. All patients hospitalized in our ICU for POP between 2001 and 2011 were included in a prospective cohort database. The diagnosis of POP was systematically assessed by reoperation and was based on intraoperative findings, as previously described [3]. Exclusion criteria were absence of intraoperative samples or negative peritoneal culture. Source control was achieved in every case.

Morbidly obese patients (body mass index (BMI) >40 kg/m^2 or >35 kg/m^2 with underlying disease related to overweight) underwent restrictive procedures (adjustable gastric banding (LABG) or sleeve gastrectomy (LSG)) or Roux-en-Y gastric bypass (RYGB).

Susceptibility Testing and Empiric Antimicrobial Therapy

Peritoneal fluid samples were systematically collected during reoperation [3]. Gram stain for direct examination and cultures were performed with identification and susceptibility testing. Blood cultures were drawn during the 24 h preceding and following reoperation. Antibiotic susceptibility was determined by the disk diffusion method [4]. Multidrug-resistant bacteria (MDR) were defined as previously described [3]. Broad-spectrum antibiotics were arbitrarily defined as piperacillin/tazobactam (pip/taz), imipenem (imi), and fluoroquinolones [3]. Interval antibiotics were defined as agents administered between the initial surgery and reoperation, for at least 24 h and started at least 24 h before reoperation.

Our institutional protocol for parenteral empiric antibiotic therapy (EAT) complies with the national [5] and international [6] guidelines for the management of intraabdominal infections. EAT is systematically initiated at the time of reoperation, takes into account the severity of the case, and usually combines pip/taz or imi with amikacin and vancomycin possibly combined with antifungal therapy based on presumed risk factors [7].

Data Collection

Demographic data, underlying medical condition [8], characteristics of the initial surgery, antibiotic regimen, and interval antibiotics were collected on ICU admission. In patients who underwent BS, BMI was recorded. The Acute Physiology and Chronic Health Evaluation II (APACHE II) [9] and the Sequential Organ Failure Assessment (SOFA) [10] were calculated on the day of reoperation for POP. Organ failure (grade ≥3 of the SOFA score) of each organ system was reported. The etiology of POP was noted. Identification and susceptibility testing of pathogens in blood cultures and peritoneal fluid were recorded.

The type and duration of EAT and definitive antibiotic therapy based on microbiologic results were recorded. Adequacy of EAT was assessed according to susceptibility testing, corresponding to all bacteria isolated susceptible to at least one antibiotic administered.

De-escalation was defined as either discontinuation of an antimicrobial agent or a change from one antibiotic to another, while escalation was defined as the addition of a new anti-infectious agent or a change of antibiotic therapy in the opposite direction.

ICU Outcome

Time to and number of reoperations, duration of mechanical ventilation, length of ICU stay, and ICU and in-hospital mortality were recorded.

Statistical Analysis

Results are expressed as mean ± one standard deviation (SD) or number and proportions. Statistical analysis used R software (R Foundation for Statistical Computing, Vienna, Austria). The BS group was compared with the cPOP group using Student *t*-test and Wilcoxon unpaired test for continuous variables and chi-square test and Fisher's exact test for discrete variables. A secondary exploratory within-group analysis was also performed. Firstly, in the cPOP group, characteristics were compared between operations performed above and below the transverse mesocolon. Secondly, in the BS group, characteristics were compared between restrictive surgery and RYGB procedures. Due to its exploratory nature, this secondary analysis did not intend to draw any definitive conclusions.

Risk factors for mortality were analyzed. ICU survivors and non-survivors were compared by univariate analysis. Odds ratio (ORs) and 95 % confidence intervals (CI) were calculated. Variables with a p-value <0.2 on univariate analysis were entered into a multivariate logistic regression analysis with backward selection. Variables with a p-value ≥0.5 at each step of the regression analysis were rejected. Interactions between final variables were tested and significant interactions ($p<0.05$) were entered in the model. The

Table 1 Main characteristics of the two groups of patients with postoperative peritonitis following conventional and bariatric surgery expressed as mean ± standard deviation (SD) or number (*n*) and proportions

	Conventional surgery (*n*=134)		Bariatric surgery (*n*=49)		Overall comparison	
	Above transverse mesocolon (*n*=47)	Below transverse mesocolon (*n*=87)	Restrictive procedures (*n*=23)	Roux-en-Y gastric bypass (*n*=26)	Conventional Surgery (*n*=134)	Bariatric surgery (*n*=49)
General characteristics at the time of initial surgery						
Age, mean years ± SD	60±17	65±16	44±10	45±10	63±16	45±10[a]
Male gender, *n* (%)	35 (74)	51 (59)	11 (48)	8 (31)	86 (64)	19 (39)[a]
Underlying fatal medical condition, *n* (%)	25 (53)	25 (29)[b]	–	–	50 (37)	–[a]
Immunocompromised condition, *n* (%)	6 (13)	11 (13)	–	1 (4)	17 (13)	1 (2)[c]
Diabetes mellitus, *n* (%)	8 (17)	11 (13)	11 (48)	8 (31)	19 (14)	19 (39)[a]
Solid tumor, *n* (%)	22 (47)	33 (38)	–	–	55 (41)	–[a]
Upper gastrointestinal tract surgery, *n* (%)	47 (100)	–	23 (100)	26 (100)	47 (35)	49 (100)[a]
Septic or contaminated surgery, *n* (%)	22 (47)	38 (44)	–	–	60 (45)	–[a]
Emergency procedure, *n* (%)	22 (47)	36 (41)	–	–	58 (43)	–[a]
Curative antibiotics for initial surgery, *n* (%)	18 (38)	28 (32)	–	–	46 (34)	–[a]
Duration of antibiotics for initial surgery, days, mean±SD	3±3	3±4	2±3	1±1	3±4	2±2
Reoperation before transfer to our ICU, *n* (%)	7 (15)	20 (23)	9 (39)	12 (46)	27 (20)	21 (43)[a]
Interval antibiotics, *n* (%)	34 (72)	60 (69)	13 (57)	15 (58)	94 (70)	28 (57)
Broad-spectrum interval antibiotics, *n* (%)	10 (21)	26 (30)	4 (17)	9 (35)	36 (27)	13 (27)
Duration of interval antibiotics, days, mean±SD	4±2	5±3	3±2	4±6	5±3	4±4
Interval between initial surgery and reoperation, days, mean±SD	9±9	10±7	10±7	11±11	10±8	11±9
Severity criteria at the time of reoperation						
White blood cell count×10^3/mL, mean±SD	17±11	19±14	15±6	20±12[d]	18±13	18±11
SAPS II at reoperation, mean±SD	47±15	49±18	43±22	45±14	49±17	45±18
APACHE II at reoperation, mean±SD	22±7	21±8	20±9	19±8	21±7	19±8
SOFA score at reoperation, mean±SD	8±3	8±4	8±5	8±4	8±3	8±4
Hemodynamic failure, *n* (%)	34 (72)	61 (70)	13 (57)	18 (69)	95 (71)	31 (63)
Respiratory failure, *n* (%)	25 (53)	43 (49)	14 (61)	16 (62)	68 (51)	30 (61)
Renal failure, *n* (%)	7 (15)	22 (25)	7 (30)	15 (58)	29 (22)	22 (45)[a]
Neurologic failure, *n* (%)	–	3 (3)	3 (13)	–	3 (2)	3 (6)
Liver failure, *n* (%)	2 (4)	–	1 (4)	–	2 (1)	1 (2)
Hematologic failure, *n* (%)	4 (9)	5 (6)	–	–	9 (7)	–
Surgical findings at reoperation						
Anastomotic leak	15 (32)	27 (31)	6 (26)	19 (73)[e]	42 (31)	25 (51)[c]
Bowel perforation	14 (30)	28 (32)	14 (61)	6 (23)[e]	42 (31)	20 (41)
Abscesses	2 (4)	15 (17)[f]	3 (13)	4 (15)	17 (13)	7 (14)
Infected ascites	8 (17)	15 (17)	1 (4)	2 (8)	23 (17)	3 (6)

[a] Overall comparison of conventional surgery and bariatric surgery, $p<0.01$

[b] In the conventional surgery group, comparisons between above and below transverse mesocolon surgery, $p<0.01$

[c] Overall comparison of conventional surgery and bariatric surgery, $p<0.05$

[d] In the bariatric surgery group, comparisons between restrictive procedures and Roux-en-Y Gastric bypass, $p<0.05$

[e] In the bariatric surgery group, comparisons between restrictive procedures and Roux-en-Y Gastric bypass, $p<0.01$

[f] In the conventional surgery group, comparisons between above and below transverse mesocolon surgery, $p<0.05$

final model with interactions was evaluated for performance with Nagelkerke's R^2, for discrimination with the c-statistic, and for calibration with Hosmer–Lemeshow's test. Statistical significance was defined as $p<0.05$.

Table 2 Micro-organisms isolated from peritoneal fluid (expressed as total number and proportions) in the two groups of patients with postoperative peritonitis following conventional and bariatric surgery

	Conventional surgery		Bariatric surgery		Overall comparison	
	Above transverse mesocolon	Below transverse mesocolon	Restrictive procedures	Roux-en-Y gastric bypass	Conventional surgery	Bariatric surgery
Aerobes	113 (81)	203 (77)	40 (82)	59 (81)	316 (79)	99 (81)
Gram-positive bacteria	47 (34)	93 (35)	29 (59)	30 (41)[a]	140 (35)	59 (48)[b]
Streptococci	15 (11)	9 (3)[c]	20 (41)	14 (19)[a]	24 (6)	34 (28)[b]
Enterococcus spp	17 (12)	58 (22)[d]	2 (4)	7 (10)	75 (19)	9 (7)[b]
Staphylococci	14 (10)	25 (10)	5 (10)	9 (12)	39 (10)	14 (11)
Gram-negative bacteria	66 (47)	110 (42)	11 (22)	29 (40)	176 (44)	40 (33)[e]
Escherichia coli	19 (14)	54 (21)	3 (6)	10 (14)	73 (18)	13 (11)
Klebsiella spp	5 (4)	13 (5)	2 (4)	5 (7)	18 (4)	7 (6)
Enterobacter spp	13 (9)	13 (5)	1 (2)	3 (4)	26 (6)	4 (3)
Other *Enterobacteriaceae*	18 (13)	12 (5)	1 (2)	7 (10)	30 (7)	8 (7)
Non-fermenting Gram-negative bacteria	7 (5)	15 (6)	1 (2)	1 (1)	22 (5)	2 (2)
Anaerobes	5 (4)	35 (13)[c]	2 (4)	3 (4)	40 (10)	5 (4)[e]
Bacteroides spp	3 (2)	23 (9)	–	2 (3)	26 (6)	2 (2)[e]
Fungi	21 (15)	25 (10)	7 (14)	11 (15)	46 (11)	18 (15)
Total number of micro-organisms	139	263	49	73	402	122
Monomicrobial infection[f]	7 (15)	12 (14)	6 (26)	5 (19)	19 (14)	11 (22)
Presence of multidrug-resistant strains[f]						
Bacteremia[f]	20 (43)	34 (39)	4 (17)	6 (23)	54 (40)	10 (20)[e]
	12 (26)	21 (24)	4 (17)	4 (15)	33 (25)	8 (16)

[a] In the bariatric surgery group, comparisons between restrictive procedures and Roux-en-Y Gastric bypass, $p<0.05$

[b] Overall comparison of conventional surgery and bariatric surgery, $p<0.01$

[c] In the conventional surgery group, comparisons between above and below transverse mesocolon surgery, $p<0.01$

[d] In the conventional surgery group, comparisons between above and below transverse mesocolon surgery, $p<0.05$

[e] Overall comparison of conventional surgery and bariatric surgery, $p<0.05$

[f] Proportions calculated per number of patients

Results

Study Population

Overall, 183 patients with POP were admitted to our ICU, of which 32 patients (65 %) in the BS group and 49 patients (29 %) in the cPOP group underwent initial surgery in another institution ($p<0.0001$). During the study period, 554 adjustable gastric bandings, 603 sleeve gastrectomies, and 1,608 RYGB were performed at our institution, with three deaths after sleeve gastrectomy and RYGB.

Clinical characteristics on admission and at the time of POP are shown in Table 1. The initial BS consisted of 15 LAGB, eight LSG, and 26 RYGB. Clinical presentations were similar in BS patients who underwent restrictive surgery or RYGB, except for a trend toward increased proportions of renal failure in patients who underwent RYGB ($p=0.055$) (Table 1). The main surgical findings at reoperation in the BS patients are displayed in Table 1. In the group of restrictive procedures, six anastomotic leaks were identified among patients with LSG (four repaired by suture and lavage/drainage and one treated by drainage and endoscopic stent; one patient required total gastrectomy with secondary anastomosis and feeding jejunostomy), and 13 gastric perforations were detected in patients after LAGB, which required removal of the band with suture of the perforation and lavage and drainage. In the RYGB group, the majority of leaks involved the gastrojejunal anastomosis. Overall, resection of the anastomosis with primary reconstruction or delayed esophagojejunostomy was performed. One patient presented stenosis of the jejunojejunal anastomosis, causing perforation of the gastric remnant, which was treated by revision of the anastomosis and total gastrectomy.

Table 3 Main agents used as empiric antibiotic therapy and definitive treatment in the two groups of patients with postoperative peritonitis following conventional and bariatric surgery expressed as number and proportions

	Empiric therapy		Definitive therapy	
	Conventional surgery (n=134)	Bariatric surgery (n=49)	Conventional surgery (n=134)	Bariatric surgery (n=49)
Monotherapy	37 (28)	6 (12)[a]	42 (31)	21 (43)
Combination therapy				
Amoxicillin/clavulanic acid	3 (2)	1 (2)	20 (15)	19 (39)[b]
Piperacillin tazobactam	79 (59)	34 (69)	37 (28)	17 (35)
Imipenem/cilastatin	38 (28)	11 (22)	41 (31)	5 (10)[b]
Third-generation cephalosporins	2 (1)	–	12 (9)	–[a]
Vancomycin	50 (37)	19 (39)	39 (29)	19 (39)[a]
Aminoglycosides	58 (43)	31 (63)[a]	18 (13)	6 (12)
Fluoroquinolones	11 (8)	2 (4)	12 (9)	2 (4)
Metronidazole	6 (4)	2 (4)	25 (19)	3 (6)[a]
Fluconazole	39 (29)	23 (47)[a]	41 (31)	19 (39)

[a]Overall comparison of conventional surgery and bariatric surgery, $p<0.05$

[b]Overall comparison of conventional surgery and bariatric surgery, $p<0.01$

Microbiologic Results

Bacteremia was reported in eight (16 %) BS patients (including four streptococci and three *Enterobacteriaceae*) and 33 (25 %) cPOP patients (including eight anaerobes, seven *Enterobacter* spp, and six *Escherichia coli* (n=6)).

A total of 122 micro-organisms were cultured from the peritoneal fluid of BS patients, and 402 micro-organisms were cultured from cPOP patients with a mean number of 2.5±1.2 versus 2.9±1.4 micro-organisms, respectively (p=0.03) (Table 2). Gram-positive strains represented 63 % of monomicrobial isolates of the BS group. Mixed infections involving Gram-negative/Gram-positive samples were observed in 12 (24 %) patients from the BS group compared to 64 (48 %) cPOP cases (p=0.006) (Table 2).

Eleven MDR strains were cultured from the 11 BS patients (eight Gram-positive including seven methicillin-resistant coagulase negative staphylococci (MRCNS) and two *Enterobacteriaceae*). A total of 73 MDR strains (35 Gram-positive and 38 Gram-negative organisms) were cultured in the cPOP group (one strain in 43 patients and ≥2 strains in 15) including MRCNS (n=24), methicillin-resistant *Staphylococcus aureus* (n=6), *Enterobacter* spp (n=13), *Pseudomonas aeruginosa* (n=9), and *E. coli* (n=7).

Candida albicans (n=11) was the predominant fungus cultured in the BS group. Susceptibility to fluconazole was confirmed in 100 % (6/6) of evaluated strains. In the cPOP group, the most frequent fungi were *C. albicans* cultured in 23 (50 % of fungi) cases (12 strains susceptible to fluconazole) and *Candida glabrata* in 13 (28 %) cases (3/6 strains resistant to fluconazole).

Table 4 Mortality and morbidity criteria in patients with postoperative peritonitis following conventional and bariatric surgery. Results are expressed as mean ± standard deviation (SD) or number (n) and proportions

	Conventional surgery (n=134)		Bariatric surgery (n=49)		Overall comparison	
	Above transverse mesocolon (n=47)	Below transverse mesocolon (n=87)	Restrictive procedures (n=23)	Roux-en-Y gastric bypass (n=26)	Conventional surgery (n=134)	Bariatric surgery (n=49)
Inadequate empiric antibiotic therapy, n (%)	24 (51)	62 (71)[a]	3 (13)	6 (23)	86 (64)	9 (18)[b]
Duration of antibiotic therapy, days, mean±SD	12±6	10±4[a]	11±5	10±3	11±5	11±4
Reoperation, n (%)	20 (43)	39 (45)	12 (52)	14 (54)	59 (44)	26 (53)
Duration of mechanical ventilation, days, mean±SD	14±15	8±10[a]	13±12	13±12	10±12	13±12
Death, n (%)	15 (32)	28 (32)	6 (26)	6 (23)	43 (32)	12 (24)
Duration of ICU stay, days, mean±SD	21±15	18±16	18±15	23±19	19±15	20±17

[a] In the conventional surgery group, comparisons between above and below transverse mesocolon surgery, $p<0.05$

[b] Overall comparison of conventional surgery and bariatric surgery, $p<0.05$

Antibiotic Therapy

At the time of reoperation for POP, EAT was initiated in all cases (Table 3). Monotherapy was administered to only a limited number of cases and mainly consisted of pip/taz (six BS patients and 32 cPOP patients). A total of 84 organisms were not adequately treated by EAT. Inadequacy of combination therapy was observed in seven (14 %) BS patients and 32 (24 %) cPOP patients. Presence of MDR strains was an important factor of inadequacy: six MDR strains were reported in six of the nine (66 %) BS patients and 41 MDR strains were reported in 32 (66 %) cPOP patients with inadequate EA therapy.

Poor clinical response and/or susceptibility testing led to escalation therapy in three (6 %) BS patients versus 31 (23 %) cPOP patients (p=0.009) at the time of definitive antibiotic therapy. De-escalation was performed in 33 (67 %) BS cases and 69 (51 %) cPOP cases (p=0.06).

Table 5 Univariate analysis of outcome at discharge from intensive care unit, expressed as mean ± standard deviation or total number (%)

Variable	Missing data	Deaths (n=55)	Survivors (n=128)	p-value	Odd ratios	95 % confidence intervals
Gender (male)	0	32 (58)	73 (57)	1	1.048	0.554–2.001
Age (year)	0	62±15	56±18	0.019	1.022	1.002–1.043
Ultimately/rapidly fatal underlying disease[a]	0	16 (29)	34 (27)	0.721	1.134	0.553–2.267
Solid tumor	0	14 (25)	42 (33)	0.383	0.699	0335–1.399
Type 1 diabetes mellitus	0	14 (25)	24 (19)	0.324	1.479	0.685–3.112
Initial emergency surgery	0	26 (47)	32 (25)	0.005	2.689	1.386–5.249
Initial surgery	0			0.649		
Below transverse mesocolon		20 (36)	53 (41)		1	–
Above transverse mesocolon		15 (27)	38 (30)		1.046	0.470–2.296
Combined		20 (36)	37 (29)		1.432	0.676–3.042
Bariatric surgery	0	12 (22)	37 (29)	0.366	0.686	0.315–1.416
Contaminated or septic initial surgery[b]	0	18 (33)	43 (34)	1	0.961	0.484–1.868
Reoperation before transfer to our unit	0	11 (20)	37 (29)	0.271	0.614	0.276–1.286
Ongoing antibiotic therapy[c]	0	33 (60)	74 (58)	0.870	1.094	0.577–2.100
Time to reoperation	2	10±9	10±8	0.572	0.996	0.955–1.034
SAPS II score	0	60±18	42±14	<0.0001	1.084	1.055–1.118
APACHE II score	0	26±6	19±7	<0.0001	1.200	1.131–1.286
SOFA score	0	11±3	7±3	<0.0001	1.504	1.316–1.763
Hemodynamic failure	0	46 (84)	80 (63)	0.005	3.066	1.432–7.193
Respiratory failure	0	37 (67)	61 (48)	0.016	2.257	1.178–4.447
Coagulation failure	0	7 (13)	2 (2)	0.003	9.187	2.133–63.143
Liver failure	0	2 (4)	1 (1)	0.215	4.792	0.449–104.429
Renal failure	0	21 (38)	23 (18)	0.005	2.819	1.389–5.744
Bacteremia	0	16 (29)	25 (20)	0.177	1.690	0.806–3.483
Polymicrobial infection	0	45 (18)	108 (16)	0.668	0.833	0.368–1.985
Infection involving *Enterobacter* spp	0	12 (22)	17 (13)	0.185	1.822	0.789–4.111
Infection involving enterococci	0	28 (51)	47 (37)	0.101	1.787	0.943–3.401
Infection involving streptococci	0	6 (11)	41 (32)	0.003	0.259	0.093–0.614
Concomitant fungal infection	0	22 (40)	40 (31)	0.307	1.466	0.756–2.822
Infection involving multidrug-resistant organisms	0	16 (29)	48 (38)	0.313	0.683	0.338–1.336
Adequate empiric therapy[c]	0	37 (67)	89 (70)	0.862	0.900	0.460–1.796
Persistent sepsis	0	48 (87)	45 (35)	<0.0001	12.647	5.592–32.715
Subsequent reoperation	0	38 (69)	47 (37)	<0.0001	3.852	1.988–7.718

SAPS simplified acute physiology score, *SOFA* sepsis-related organ failure assessment

[a] Classification of McCabe and Jackson (14)

[b] Polk/Altemeier classification

[c] At the time of diagnosis of postoperative peritonitis

At the time of definitive therapy, monotherapy mainly consisted of amoxicillin/clavulanic acid in BS patients (12 (24 %) patients), while in the cPOP group, monotherapy was based on amox/clav (n=15, 11 %), pip/taz (n=14, 10 %), or imi (n=8, 6 %). Overall, amox/clav represented 34 (69 %) of all definitive therapies in BS cases. Antifungal therapy, mainly fluconazole, was given in 21 (43 %) BS patients and 46 (34 %) cPOP cases (Table 3).

Patient Outcome

Following the first reoperation in our institution, 19 (39 %) BS patients and 75 (56 %) cPOP patients had a favorable outcome (p=0.04) (Table 4). A total of 12 (24 %) BS patients and 43 (32 %) cPOP patients died (p=0.32) after a mean interval of 17±16 vs 21±16 days, respectively (p=0.37). No significant difference was observed between BS patients treated by restrictive surgery or RYGB.

The risk factors for death identified on univariate analysis are presented in Table 5. The BS variable was forced into the multivariate logistic regression analysis model. No significant interaction was observed between the final variables. On multivariate analysis, four criteria were significantly associated with outcome, but none of them were specifically linked to BS (Table 6).

Discussion

To the best of our knowledge, our results provide a unique picture of patients who develop POP following BS. These BS patients represent an atypical group that differs from cases of cPOP or cannot be considered to be similar to patients with complicated upper mesocolic surgery. Our highly selected population and the observational study design could be considered to be poorly representative of the complications of BS as most of these complicated cases are treated in surgical wards. We nevertheless assume that this global analysis could provide general conclusions that could be applied to all complicated cases of BS in the ICU setting, although RYGB appears to present a number of specificities. In addition, our recruitment does not reflect the local incidence of these complications. Consequently, we cannot provide a clear estimate of the proportion of BS patients requiring ICU admission.

In studies reporting cPOP patients admitted to the ICU, the proportions of upper mesocolic cases usually ranged between 13 and 30 % of cases [11–14]. While leak rates are close to zero in the postoperative course of gastric banding [15–17], rates as high as 20 % have been observed after RYGB. Recent publications report mortality rates after anastomotic leaks ranging between 6 and 22 % [18–20] and up to 66 % in some series [21, 22] of RYGB. The delayed diagnosis of these leaks following BS ranges between 1 and 18 days [23] as they are frequently asymptomatic or associated with limited clinical signs [18, 23, 24]. This paucity of symptoms has been previously reported in ICU cases [2]. The large number of reoperations performed before transfer to our institution suggests that the postoperative complication was diagnosed early in many cases. However, technical issues and recurrent or persisting infections justified transfer of a large number of cases.

Polymicrobial infections and prior antibiotic usage are common in the course of POP and may create a bias in the samples retrieved. The high frequency of Gram-positive cocci and fungi reported in BS cases is not surprising as it has been previously observed in patients with gastroduodenal or upper mesocolic perforations, including cPOP cases [25]. The microbiologic characteristics of patients who underwent complicated RYGB have not been previously studied. Our results suggest that these patients should be considered as having small bowel perforation rather than upper gastrointestinal perforation, but the overall ICU clinical management does not appear to be different from that applied to restrictive BS cases. High concentrations of aerobes, anaerobes, and fungi have been reported in the stomach flora of patients undergoing bypass for morbid obesity [26]. The high pH reported in these patients is also a predisposing factor to yeast growth [26]. The prior use of antibiotic therapy before the diagnosis of POP is a major risk factor for the emergence of MDR strains and fungi. This

Table 6 Multivariate analysis (with backward selection but similar results with forward and stepwise selection)

Variable	Odd ratios	95 % confidence intervals	p-value	In the original dataset	Corrected for optimism (bootstrapping)
Initial emergency surgery	3.963	1.586–10.576	0.0130		
APACHE II score (per 1 point increase)	1.177	1.096–1.276	<0.0001		
Infection involving streptococci	0.316	0.097–0.916	0.0088		
Persistent sepsis	11.241	4.336–33.532	<0.0001		
Nageelkerke R^2				0.54	0.515
c-statistic				0.89	0.88
Hosmer–Lemeshow test				0.68	

risk of MDR strains justifies the use of EAT protocols comprising broad-spectrum agents [3]. Interestingly, the overall proportion of MDR strains remains low in BS cases and allows de-escalation therapy in most cases [3]. These observations are helpful to guide EAT and suggest that complicated BS patients are at moderate risk for harboring MDR strains and at high risk of fungal infection. Based on the candida peritonitis score [7], our local protocol recommends early antifungal therapy in these patients. This combined approach allows an acceptable adequacy of 80 % of all empiric therapy in BS cases, much higher than that observed in cPOP patients.

Recent studies have reported contradictory results on the prognosis of morbidly obese patients admitted to the ICU, from a decreased risk of in-hospital mortality in surgical patients [27] to increased morbidity in a mixed population [28] and even an increased risk of death among surgical patients [29]. When compared to BS cases treated conservatively, in whom no death is reported, the patients who require reoperation have high mortality rates of up to 18 to 22 % [24, 30], and even to 40 % in some specific subpopulations [31]. Despite their younger age and a low incidence of underlying disease, our BS patients demonstrated similar levels of severity, and even higher initial rates of renal failure than cPOP patients. This point suggests that these patients should be considered to be at high risk of complications and death, although BS did not appear to be a significant risk factor for mortality on multivariate analysis.

Conclusion

The present data suggest that, despite a younger age, the severity of POP following BS results in high mortality rates, similar to those observed in older patients with cPOP. The usual empiric antibiotic therapy protocols should be applied because of the potential risk of MDR strains, but de-escalation can be performed in most cases.

Conflict of Interest All the investigators were independent of any commercial funder and have no conflict of interest to disclose.

References

1. Chen CC, Huang MT, Wei PL, et al. Severe peritonitis due to Streptococcus viridans following adjustable gastric banding. Obes Surg. 2010;20(11):1603–5. Epub 2009 Dec 17. PMID: 20012705.
2. Kermarrec N, Marmuse JP, Faivre J, et al. High mortality rate for patients requiring intensive care after surgical revision following bariatric surgery. Obes Surg. 2008;18(2):171–8. Epub 2008 Jan 05. PMID: 18175195.
3. Augustin P, Kermarrec N, Muller-Serieys C, et al. Risk factors for multidrug resistant bacteria and optimization of empirical antibiotic therapy in postoperative peritonitis. Crit Care. 2010;14(1): R20. Epub 2010 Feb 17. PMID: 20156360.
4. Members of SFM Antibiogram Committee. Comité de l'Antibiogramme de la Société Française de Microbiologie. Available at: http://www.sfm-microbiologie.org/UserFiles/file/CASFM/casfm_2010.pdf.
5. Auboyer C. [Guidelines of the SFAR (Societe Francaise d'Anesthesie et de Reanimation). Antibiotic combinations or monotherapy in surgery and surgical intensive care. Extracts relating to the "visceral surgery" conference of experts]. J Chir. 2000;137(6):333–6. Epub 2000/12/19. PMID: 11119027.
6. Solomkin JS, Mazuski JE, Bradley JS, et al. Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America. Clin Infect Dis. 2010;50(2):133–64. Epub 2009/12/26. PMID: 20034345.
7. Dupont H, Bourichon A, Paugam-Burtz C, et al. Can yeast isolation in peritoneal fluid be predicted in intensive care unit patients with peritonitis? Crit Care Med. 2003;31(3):752–7. Epub 2003 Mar 11. PMID: 12626979.
8. Montravers P, Gauzit R, Muller C, et al. Emergence of antibiotic-resistant bacteria in cases of peritonitis after intraabdominal surgery affects the efficacy of empirical antimicrobial therapy. Clin Infect Dis. 1996;23(3):486–94. Epub 1996 Nov 01. PMID: 8879770.
9. Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification system. Crit Care Med. 1985;13(10):818–29. Epub 1985 Oct 01. PMID: 3928249.
10. Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med. 1996;22(7):707–10. Epub 1996 Jul 01. PMID: 8844239.
11. Montravers P, Lepape A, Dubreuil L, et al. Clinical and microbiological profiles of community-acquired and nosocomial intra-abdominal infections: results of the French prospective, observational EBIIA study. J Antimicrob Chemother. 2009;63(4):785–94. Epub 2009 Feb 07. PMID: 19196742.
12. Riche FC, Dray X, Laisne MJ, et al. Factors associated with septic shock and mortality in generalized peritonitis: comparison between community-acquired and postoperative peritonitis. Crit Care. 2009;13(3):R99. Epub 2009 Jun 26. PMID: 19552799.
13. Roehrborn A, Thomas L, Potreck O, et al. The microbiology of postoperative peritonitis. Clin Infect Dis. 2001;33(9):1513–9. Epub 2001 Sep 25. PMID: 11568851.
14. Seguin P, Fedun Y, Laviolle B, et al. Risk factors for multidrug-resistant bacteria in patients with post-operative peritonitis requiring intensive care. J Antimicrob Chemother. 2010;65(2):342–6. Epub 2009 Dec 17. PMID: 20008043.
15. Facek M, Receveur I, Darbar A, et al. Prosthesis related sepsis following laparoscopic adjustable gastric banding. ANZ J Surg. 2010;80(7–8):506–9. Epub 2010 Aug 28. PMID: 20795963.
16. Nocca D, Aggarwal R, Blanc P, et al. Laparoscopic vertical banded gastroplasty. A multicenter prospective study of 200 procedures. Surg Endosc. 2007;21(6):870–4. Epub 2006 Nov 15. PMID: 17103270.
17. Weiner R, Blanco-Engert R, Weiner S, et al. Outcome after laparoscopic adjustable gastric banding—8 years experience. Obes Surg. 2003;13(3):427–34. Epub 2003 Jul 05. PMID: 12841906.

18. Al-Sabah S, Ladouceur M, Christou N. Anastomotic leaks after bariatric surgery: it is the host response that matters. Surg Obes Relat Dis. 2008;4(2):152–7. discussion 157–158. Epub 2008 Feb 26. PMID: 18294924.
19. Csendes A, Burdiles P, Burgos AM, et al. Conservative management of anastomotic leaks after 557 open gastric bypasses. Obes Surg. 2005;15(9):1252–6. Epub 2005 Nov 02. PMID: 16259881.
20. Fernandez Jr AZ, Demaria EJ, Tichansky DS, et al. Multivariate analysis of risk factors for death following gastric bypass for treatment of morbid obesity. Ann Surg. 2004;239(5):698–702. discussion 702–693. Epub 2004 Apr 15. PMID: 15082974.
21. Fernandez Jr AZ, DeMaria EJ, Tichansky DS, et al. Experience with over 3,000 open and laparoscopic bariatric procedures: multivariate analysis of factors related to leak and resultant mortality. Surg Endosc. 2004;18(2):193–7. Epub 2003 Dec 24. PMID: 14691697.
22. Papasavas PK, Caushaj PF, McCormick JT, et al. Laparoscopic management of complications following laparoscopic Roux-en-Y gastric bypass for morbid obesity. Surg Endosc. 2003;17(4):610–4. Epub 2003 Feb 13. PMID: 12582772.
23. Thodiyil PA, Yenumula P, Rogula T, et al. Selective nonoperative management of leaks after gastric bypass: lessons learned from 2675 consecutive patients. Ann Surg. 2008;248(5):782–92. Epub 2008 Oct 25. PMID: 18948805.
24. Ballesta C, Berindoague R, Cabrera M, et al. Management of anastomotic leaks after laparoscopic Roux-en-Y gastric bypass. Obes Surg. 2008;18(6):623–30. Epub 2008 Apr 09. PMID: 18392906.
25. de Ruiter J, Weel J, Manusama E, et al. The epidemiology of intra-abdominal flora in critically ill patients with secondary and tertiary abdominal sepsis. Infection. 2009;37(6):522–7. Epub 2009 Aug 12. PMID: 19669089.
26. Ishida RK, Faintuch J, Paula AM, et al. Microbial flora of the stomach after gastric bypass for morbid obesity. Obes Surg. 2007;17(6):752–8. Epub 2007 Sep 21. PMID: 17879574.
27. Hutagalung R, Marques J, Kobylka K, et al. The obesity paradox in surgical intensive care unit patients. Intensive Care Med. 2011;37(11):1793–9. Epub 2011 Aug 06. PMID: 21818652.
28. Sakr Y, Madl C, Filipescu D, et al. Obesity is associated with increased morbidity but not mortality in critically ill patients. Intensive Care Med. 2008;34(11):1999–2009. Epub 2008 Aug 02. PMID: 18670756.
29. Nasraway Jr SA, Albert M, Donnelly AM, et al. Morbid obesity is an independent determinant of death among surgical critically ill patients. Crit Care Med. 2006;34(4):964. quiz 971. Epub 2006 Feb 18. PMID: 16484910.
30. Marshall JS, Srivastava A, Gupta SK, et al. Roux-en-Y gastric bypass leak complications. Arch Surg. 2003;138(5):520–3. discussion 523–524. Epub 2003 May 14. PMID: 12742956.
31. Lee S, Carmody B, Wolfe L, et al. Effect of location and speed of diagnosis on anastomotic leak outcomes in 3828 gastric bypass cases. J Gastrointest Surg. 2007;11(6):708–13. Epub 2007 Jun 15. PMID: 17562118.